Characterization of legacy waste, screened fractions and performance efficiency of screening machines at three landfill mining sites

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Abstract

In this research, an extensive examination and analysis of legacy waste were conducted, focusing on screened fractions, including refused derived fuel (RDF), inert, and fine fractions. The study evaluated the performance efficiency of processing units, namely rotary screens, disc screens, and vibrating screens, at three bio-mining sites in Haryana state: Kail (KLY), Patvi (PTA), and Bandhwari (BDG) Figure 1.

To assess the composition of legacy waste, samples were extracted from different layers of landfills (top layer 1 m below surface, middle layer 2.0 m below surface, and bottom layer up to 3.0 m below surface) and manually sorted and characterised. The waste composition at various depths for each site revealed distinct patterns. For instance, at dumpsite KLY, the composition varied from 12.19% to 37.67% for plastics, 60.08% to 2.27% for cloth, C&D, wooden material, other combustible material, and fine fraction (Figure 2,3&4). Furthermore, the study examined the density, moisture content, volatile matter, ash content, and calorific value of legacy waste at different depths. Variations in bulk density indicated the influence of factors such as evaporation, degradation of organic matter, temperature, and moisture conditions at different layers of the landfill.

The analysis of screened fractions (RDF, inert, and fine fraction) across all bio-mining sites highlighted significant impurities (25-60%) in RDF and inert fractions. The higher composition of the fine fraction at BDG suggested effective recovery of recyclables in high-income group cities with robust waste management structures.

The waste composition results indicated that smaller cities with lower income groups had a poor quantum of valuable recyclables, leading to ineffective waste management structures and a higher percentage of waste ending up in dump sites.

The study also assessed the concentration of Cr and Zn in fine fractions, finding that Cr concentrations at KLY and PTA exceeded FCO standards, while Zn in the fine fraction at KLY slightly exceeded the FCO standards.

Additionally, the research investigated the screening efficiency of different screens at various sites. The trommel screens at KLY exhibited maximum efficiency at specific feed rates, while advanced screens at BDG showed varying screening efficiencies with different screening capacities.

In conclusion, this study provides valuable insights into the composition, characteristics, and screening efficiency of legacy waste at different bio-mining sites in Haryana, contributing to the understanding of waste management practices and the need for tailored approaches in different city contexts.

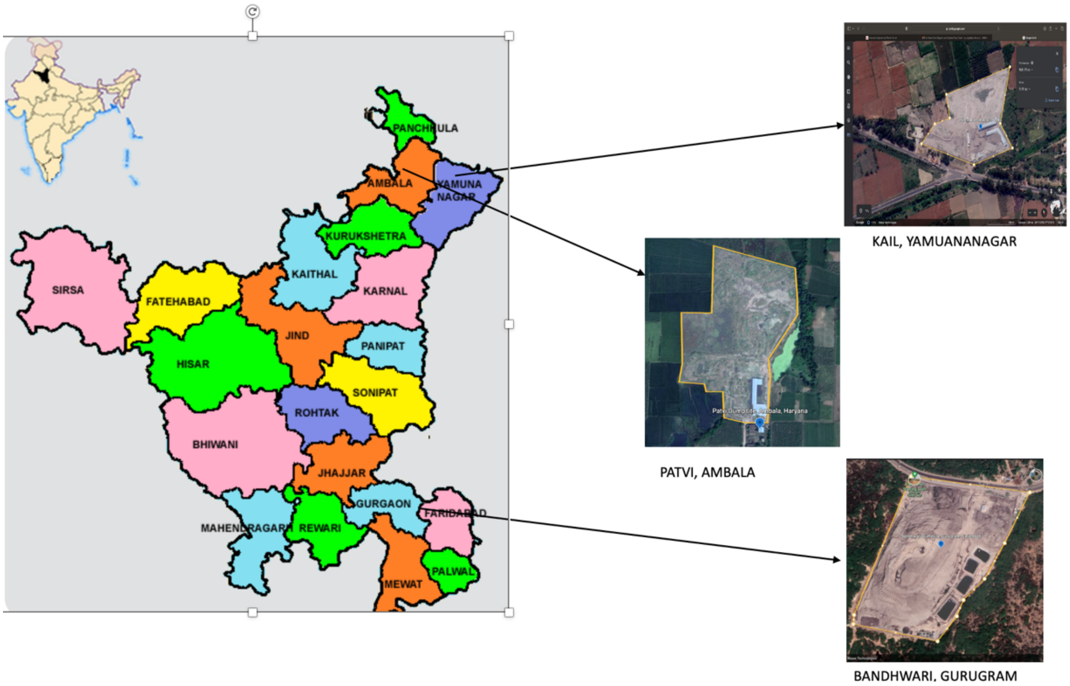

Figure 1. Bio-mining project sites at KLY, PTA and BDG in google map and satellite image.

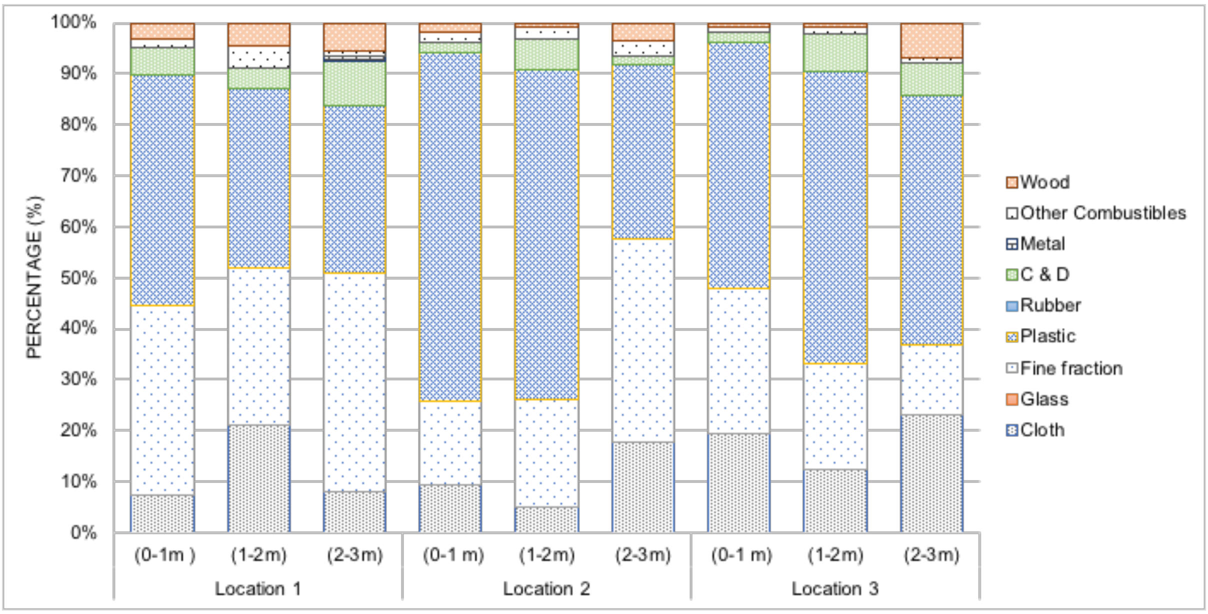

Figure 2. Composition of excavated waste in different categories at three depths of three locations at KLY dumpsite

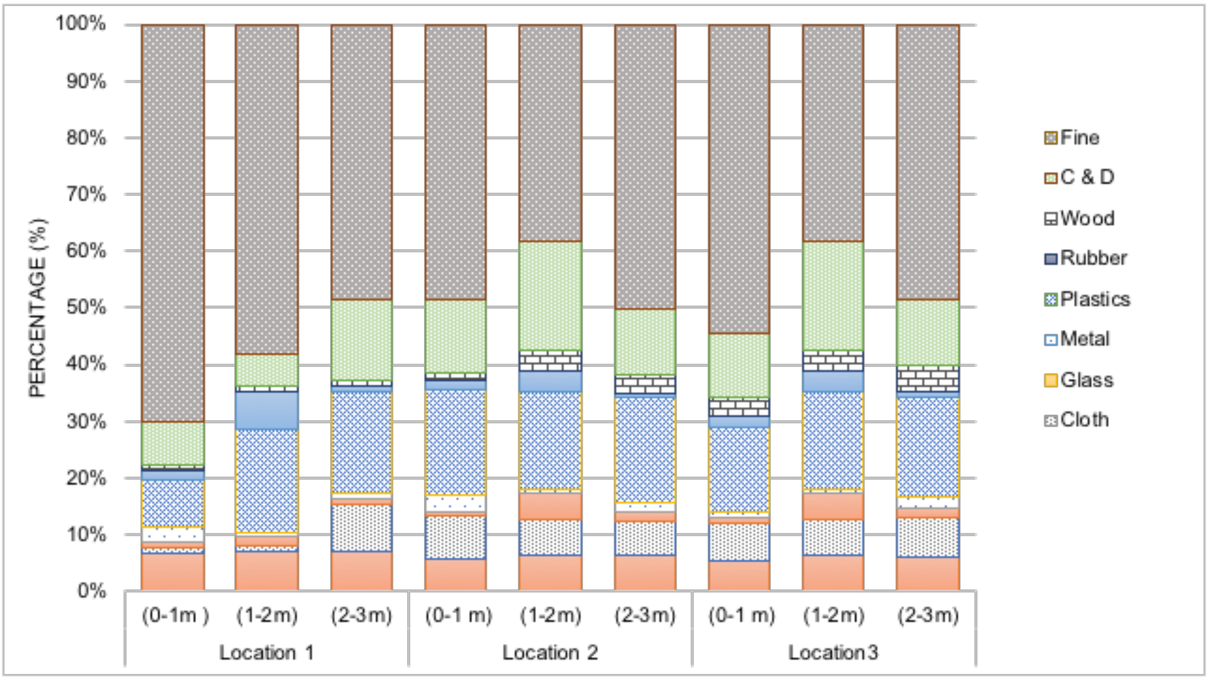

Figure 3. Composition of excavated waste in different categories (metal, C&D, Rubber, Plastic, Soil, Glass, and Cloth) at three different depths of 1-3m of three locations of PTA.

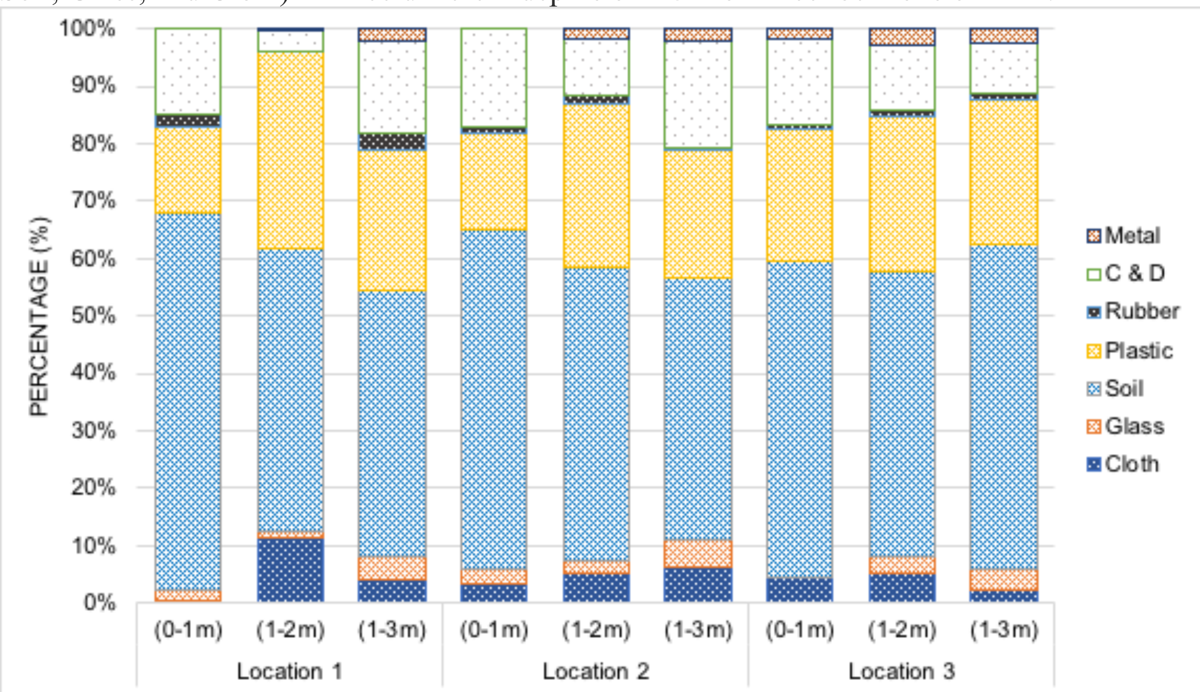

Figure 4. Composition of excavated waste in different categories (Fine fraction, C&D, Wood, Rubber, Plastics, Metals, Glass, and Cloths) at three different depths of 1-3m of three locations of BDG.

Table 1. Physical-chemical analysis results of fine fraction for PTA, KLY and BDG bio-mining sites.

S. No.	Parameter	Units	PTA	KLY	BDG	FCO (2009) Standards
1	pH (1:5)	-	8.14±0.42	7.48±0.82	7.3±1.4	6.5-7.5
2	Colour	-	Dark brown	Blackish	Dark Brown	Dark Brown to Black
3	Odour	-	Odourless	Odourless	Odourless	Absence of odour
4	Moisture Content at 105°C	%	18.74±5.6	16.68±2.6	17.5±4.6	25
5	EC (1:5)	pmhos/cm	766±60.6	395±0.81	360±1.2	<4000
6	Particle Size (Pass through 4.0 mm IS sieve)	%	98.0±11.3	92.25±14.6	98.0 ±14.7	90 % Pass through 4.0 mm IS Sieve
7	Bulk Density	gm/cc	0.99±0.12	0.93±0.3	0.9±0.21	0.7-0.9
8	Total organic Carbon	%	9.28±2.4	14.35±2.6	12.2±2.6	>18.0
9	Total Nitrogen (as N)	%	0.47±0.15	0.95±0.24	1.1±0.05	>1.0
1	Total Phosphate (as P205)	%	0.55±0.13	0.45±0.15	0.3±0.02	>0.5
1	Potassium (as K_2O)	%	0.36±0.08	0.42±0.07	0.2±0.06	>0.8
1	C: N Ratio	-	19.0±3.5	15.0±2.6	11.0±1.6	20.0

In conclusion, trommels have demonstrated superior efficiency in screening mining waste, utilising various screen sizes (100-125mm, 75-80mm, 40-50mm, 20-25mm, 10-14mm, and 4-6mm), complemented by density separators, air flow systems, and centrifuges. This combination ensures high-quality Refused Derived Fuel (RDF) and fine fractions with minimal impurities. The selection of trommel screen sizes is intricately linked to the waste composition and characteristics targeted for mining.

It is suggested that the overall cost of a mining project is significantly influenced by the distance to disposal facilities for mined fractions, such as Waste Incineration facilities for combustible fractions, agriculture fields or low-lying areas for fine fractions, and landfills for inert fractions. In India, the scarcity of Waste Incineration facilities and reluctance of Cement Industries to accept RDF from dumpsite mining projects due to excess availability and poor quality of RDF often result in the accumulation of mined waste at dumpsites. Hence, careful planning of disposal arrangements and accounting for transportation costs to final disposal facilities are essential considerations in project cost calculations.

In a country like India, where minimal recovery of recyclables occurs from dumpsite mining projects due to the predominant roles of informal waste managers (Rag pickers, Kabadiwalas), coupled with high transportation costs for combustible fractions, these projects may not be economically profitable in terms of resource recovery. Metropolitan cities like BDG, with well-established informal waste management systems, exhibit negligible valuable recyclables compared to smaller cities like KLY and PTA, where the absence of informal waste managers results in higher proportions of plastics and other combustible fractions.

However, the benefits of dumpsite mining projects extend beyond economic considerations. These projects contribute to reclaimed land, environmental protection from further contamination, improved public health, increased asset value, and potential savings in acquiring additional land for fresh waste management sites. These projects' holistic assessment must consider economic and environmental factors for a comprehensive understanding of their impact.

References

Ashkiki, A. R., C. Felske and D. Mccartney (2019). "Impacts of seasonal variation and operating parameters on double-stage trommel performance." Waste Management 86: 36-48.

MoEFCC, 2016. Solid Waste Management Rules, 2016, The Gazette of India.

Savage, G.M., 1994. Landfill Mining and Reclamation. ISWA Time, pp. 4.

Pujari, P.R., Deshpande, V., 2005. Source apportionment of groundwater pollution around landfill site in Nagpur. India. Environ. Monit. Assess. 111, 43–54, http://dx.doi.org/10.1007/s10661-005-8037-4.

Mor, S., Ravindra, K., Dahiya, R.P., Chandra, A., 2006. Leachate characterization and assessment of groundwater pollution near municipal solid waste landfill site. Environ. Monit. Assess. 118, 435–456, http://dx.doi.org/10.1007/s10661-006- 1505-7.

Sharholy, M., Ahmad, K., Mahmood, G., Trivedi, R.C., 2008. Municipal solid waste management in Indian cities - A review. Waste Manag. 28, 459–467, http://dx.doi.org/10.1016/j.wasman.2007.02.008.

Kumar, A., 2013. Existing situation of municipal solid waste management in NCT of Delhi. India. Int. J. Soc. Sci. 1, 6–17.